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FINANCIAL INTEGRATION WITH AND WITHOUT INTERNATIONAL POLICY COORDINATION

by

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Abstract

This paper studies the relationship between international capital mobility and international policy coordination. I show that: (i) a regime with capital mobility results in higher welfare levels than a regime without it provided that governments coordinate their macroeconomic policies, and that (ii) in the absence of policy coordination, capital mobility results in lower welfare levels than portfolio autarky.

These results follow from the fact that financial integration enhances the impact of domestic government financial policies on foreign interest rates, real allocations, and welfare. Therefore, financial integration increases the welfare losses from noncooperative policymaking.

The policy message is that financial integration, of the type attempted by European countries, can be successful if and only if governments agree to coordinate their macroeconomic policies.

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I. Introduction

A central development in recent times is the increased integration of financial markets across countries. Financial integration is currently being promoted by government policies. A noteworthy example is the European Economic Community's ambitious proposal to abolish restrictions in financial flows between member countries by the end of 1992 [1]. In this case, one of the main issues that still has to be resolved is the extent to which governments will agree to surrender their sovereign power over fiscal and monetary policy to a central "European" authority. Some governments, particularly the British, agree on financial liberalization but refuse to give up their independence in the day to day management of macroeconomic policy.

In this paper I argue that international policy cooperation is necessary for the success of financial liberalization. More precisely, I show that a regime in which financial capital is mobile across countries results in substantially higher world welfare than a regime without capital mobility provided that governments coordinate their macroeconomic policies. In contrast, in the absence of coordination world welfare is greater without international capital mobility.

The intuition for these results stems from the fact that financial liberalization increases the interdependence of macroeconomic policies, and in particular, of government financial policies. For instance, the effects of an increase in the United States budget deficit on foreign interest rates are greater the stronger the links between United States and foreign financial markets. If the United States government acts independently of foreign governments it is likely to ignore the international effects of its deficit and thus underestimate its social costs.

Since financial integration increases the international effects of domestic policies, it may increase the welfare losses due to "beggar thy neighbor" policy making. These increased losses may (and, in the model below, do) exceed the benefits from financial integration.

The policy message of this paper is straightforward. Financial liberalization can be very beneficial if governments commit themselves to coordinating their macroeconomic policies. If governments retain sovereignty in macroeconomic policy making, financial liberalization may make all countries worse off.

I develop these ideas in the context of a two country overlapping generations model (Samuelson (1958)). In each period, the government of each country chooses a fiscal deficit, which takes the form of a transfer payment to domestic individuals, and issues as much debt as needed to finance its transfer and repay debt issued in previous periods.

The model is constructed so that savings functions fluctuate over time in each country, but the world savings behavior does not fluctuate. Each government has a mandate to try to ameliorate the effects of fluctuations by using the aforementioned transfers. I formalize this mandate by assuming that the fiscal deficit policy chosen by each government maximizes a social welfare function that weights the utility of all currently alive and future domestic generations.

There is free trade in consumption goods. With respect to international capital markets, I consider two possibilities: a Portfolio Autarky regime (PA) in which residents of each country are not allowed to engage in international borrowing or lending, and a perfect Capital Mobility (CM) regime in which residents of both countries can freely borrow or lend to citizens abroad.

In a PA regime, fiscal deficits have no international effects, and international policy coordination is irrelevant. I derive optimal deficit policies for both countries in PA and show that, given these policies, interest rates and debt fluctuate in each country. In a Portfolio Autarky regime, fiscal deficits cannot eliminate fluctuations because countries cannot run trade surpluses or deficits.

In a CM regime, arbitrage ensures that domestic and foreign interest rates are equal to each other, and equal to the "world" interest rate. The fiscal deficit of one country affects, through its effect on the world interest rate, real allocations and welfare in the other country. Thus fiscal deficits have international effects and it matters whether or not governments coordinate their policies.

I study a symmetric cooperative CM regime in which governments delegate their policy decisions to a world planner that is instructed to maximize total world welfare. I derive the optimal cooperative deficit policies, and show that they eliminate fluctuations in interest rates and world debt. This is possible because the world fundamentals do not fluctuate, and in a CM regime countries can smooth consumption by borrowing and lending in the international markets. As a result, world welfare (as measured both by total welfare and, provided governments do not discount the future too heavily, by the two countries' welfare functions) in a cooperative CM regime is higher than in PA.

Finally, I study a noncooperative CM regime in which each government chooses its fiscal deficit policy independently in order to maximize its own country's welfare function. This regime takes the form of a dynamic game in which governments are the players and their fiscal deficits are strategies. I show that this dynamic game has a closed loop Nash equilibrium. The deficit policies chosen in this Nash equilibrium result in a constant world interest rate and debt quantity. However, the resulting world interest rate is larger than under cooperation, a reflection of the fact that governments underestimate the world cost of their deficits. As a consequence, world welfare is lower in a noncooperative CM regime than in a cooperative CM regime.

I show that world welfare in a noncooperative CM regime is always lower than in PA. This result is somewhat surprising because one could have expected there to be a tradeoff between the benefits of capital mobility and the losses from noncooperative behavior. In the model I present below no such tradeoff exists, and portfolio autarky is always superior to capital mobility if governments behave noncooperatively.

This paper is a direct descendant of my previous work (Chang (1987,1988)) on the international coordination of fiscal deficits and the structure of international capital markets. These papers emphasized the public finance aspects of international coordination of fiscal and monetary policies. This emphasis is shared by the contributions of Canzoneri and Rogers (1988) and Casella and Feinstein (1989).

This paper is also related to recent studies on the welfare gains from capital mobility and financial liberalization. Results by Feldstein and Horioka (1982) and Cole and Obstfeld (1988) suggest that these gains must be relatively small. In this paper I show that the welfare gains from financial liberalization may be very large provided that governments choose optimal cooperative policies. But no matter how large the potential gains from capital mobility may be, financial liberalization may result in a net welfare loss in the absence of policy coordination.

The plan of the paper is the following: Section II presents the model. Section III discusses optimal policies in Portfolio Autarky. Section IV derives optimal policies in a symmetric cooperative CM regime, and compares the outcomes with the PA outcomes. Section V discusses the noncooperative CM regime, and compares its properties with those of the PA and the cooperative CM regime. Section VI concludes. Some technical proofs are deferred to an Appendix.

II. The Model

I will discuss an overlapping generations world of two countries, "home" and "foreign", denoted by $i = 1, 2$ [2]. At the beginning of each period $t = 1, 2, \ldots$ a new agent is born in each country. We will refer to the agent born at t in country i as agent (i,t). Each agent lives for two consecutive periods, "youth" and "old age". The only exception to this rule is "generation zero", composed of two agents, one domestic and one foreign, who live only in period one and will be indexed by (i,0). Thus, there are four agents alive in each period, two young and two old, two "domestic" and two foreign.

There is only one homogeneous, nonstorable consumption good which is freely traded in the world market [3]. There is no physical capital, in therefore in what follows any reference to "capital" is to "financial" capital. The consumption good is produced in each period with only the labor of young people: if agent (i,t) works n_{it} hours his output is n_{it} units of consumption.

Agent (i,t) consumes only when old. His preferences are given by:

$$U_{it}(n_{it}, c_{i,t+1}) = K_{i,t+1} c_{i,t+1} - \frac{n_{it}^2}{2} \tag{1}$$

where $c_{i,t+1}$ denotes (i,t)'s consumption in old age and $K_{i,t+1}$, a positive number, is agent (i,t)'s marginal utility of old age consumption.

The decision problem of agent (i,t) is to choose labor effort n_{it} and old age consumption $c_{i,t+1}$ to maximize (1) subject to his lifetime budget constraint. Let R_{it} be the gross interest rate prevailing in country i for one period loans between t and t+1. Agent (i,t)'s budget constraint is:

$$c_{i,t+1} = R_{it} n_{it} + \tau_{i,t+1}, \quad n_{it} \in [0, N], \quad c_{i,t+1} \geq 0 \tag{2}$$

In (2), $\tau_{i,t+1}$ denotes a transfer (tax, if negative) from government i to agent (i,t) in his old age, and N is a (large) bound on labor effort. Agent (i,t) has perfect foresight and takes R_{it} and $\tau_{i,t+1}$ as given. The maximization of (1) subject to (2) yields:

$$n_{it} = K_{i,t+1}R_t \tag{3a}$$

$$c_{i,t+1} = K_{i,t+1}R_t^2 + \tau_{i,t+1} \tag{3b}$$

provided $R_t \in [0, \frac{N}{K_{i,t+1}}]$, which turns out to be the case in equilibrium.

Notice that both n_{it} and $c_{i,t+1}$ depend positively on $K_{i,t+1}$ for any R_t and $\tau_{i,t+1}$. The intuition is that $K_{i,t+1}$ is the marginal utility of old age consumption. A larger value of $K_{i,t+1}$ increases labor effort and savings.

For future reference, notice that the maximized utility of agent (i,t) is given by the <u>indirect utility function:</u>

$$w_{it}(R_{it},\tau_{i,t+1}) = \frac{1}{2} K_{i,t+1}^2 R_t^2 + K_{i,t+1} \tau_{i,t+1} \tag{4}$$

Agent (i,0) simply consumes the value of the transfer τ_{i1} that he receives from the government. His utility is then $K_{i1}\tau_{i1}$.

The government of each country i = 1,2 is assumed to choose a <u>transfer policy</u> $\tau^i \equiv (\tau_{i1},\tau_{i2},\ldots)$. Aside from these transfers and debt repayments, governments have no other expenditures. Each period, the government of country i issues a number b_{it} of one period bonds to finance the transfer τ_{it} and to repay bonds issued the period before. Government bonds pay the market interest rate. For simplicity, I shall assume that there is no government debt due in period one[4]. Thus, the evolution of government i's debt is given by:

$$b_{it} = R_{i,t-1}b_{i,t-1} + \tau_{it} \tag{5}$$

where $b_{i0} = 0$.

By definition, τ_{it} is the <u>(primary) fiscal deficit</u> of country i in period t. Thus, a policy τ^i is a sequence of fiscal deficits of government i. A pair $\tau = (\tau^1, \tau^2)$ will be called a <u>joint policy</u>.

Where each government can sell its debt depends on the international regime. I will consider two possibilities. In a <u>Portfolio Autarky regime</u> (PA)[5], private agents are not allowed to borrow from or lend to foreigners. In PA interest rates may be different across countries, i.e, R_{1t} need not equal R_{2t}. The opposite regime will be called <u>perfect Capital Mobility</u> (CM). In a CM regime, private agents can freely borrow and lend internationally. In that case, arbitrage ensures the equality of interest rates across countries, and one can properly define "the" <u>world</u> interest rate by $R_t \equiv R_{1t} = R_{2t}$. The international regime is given at the beginning of time and remains in place forever[6]. The rest of this paper analyzes the merits of CM relative to PA.

In order to examine the gains from international capital mobility, I assume that each country has a <u>two period deterministic cycle</u> which is perfectly and negatively correlated with that of the other country. That is, I will assume that for some $H \geq L > 0$:

$$K_{it} = H \quad \text{if } i = 1 \text{ and } t \text{ is odd or if } i = 2 \text{ and } t \text{ is even} \tag{6a}$$

$$K_{it} = L \quad \text{if } i = 1 \text{ and } t \text{ is even of if } i = 2 \text{ and } t \text{ is odd} \tag{6b}$$

Thus, if t is odd then there is a "low saver" in the home economy and a "high saver" abroad. The opposite happens if t is even. Assumption (6) implies that from the viewpoint of each country both the marginal benefit of τ_{it} and national savings functions fluctuate over time. However, the <u>world</u> fundamentals are the same in every period, and it is technologically feasible for both countries to smooth consumption and production over time.

I assume that consumption smoothing over time is desirable, and that governments have a mandate to use their fiscal deficit policies to ameliorate the effects of fluctuations. Formally, each government will be assumed to maximize a weighted discounted sum of the utilities of all current and future domestic generations:

$$P_i(\tau_1,\tau_2) = (1-\beta)\left[\frac{K_{i1}\tau_{i1}}{\beta} + \sum_{t=1}^{\infty} \beta^{t-1} w_{it}(R_{it},\tau_{i,t+1})\right] \tag{7}$$

where $P_i(\tau^1,\tau^2)$ is the value of government i's social welfare function when the joint policy $\tau = (\tau^1,\tau^2)$ is chosen. The social welfare function (7) is just the sum, discounted by β, of the marginal utility of the transfer to generation (i,0) and the indirect utility function of all generations born in country i. The discount factor β is assumed to be between zero and one. As β goes to one, the social welfare function (7) converges to an average criterion (see Abel (1987)).

Notice that governments are assumed to be totally benevolent in the sense that their objectives depend only on private welfare. On the other hand, they are assumed to be nationalistic in the sense that the objective function (7) does not include the welfare of foreigners.

A great advantage of our specification is that the social welfare function (7) can be expressed as a discounted sum of a function of contemporaneous variables, as:

$$P_i(\tau_1,\tau_2) = \sum_{t=1}^{\infty} \beta^{t-1} (1-\beta)(\frac{K_{it}\tau_{it}}{\beta} + \frac{1}{2} K_{i,t+1}^2 R_{it}^2) \quad (8)$$

The reader may have noticed that the social welfare function (7) or (8) is defined in terms of interest rates and therefore makes sense only for joint policies $\tau = (\tau^1,\tau^2)$ that result in a competitive equilibrium. In order to extend the definition of $P_i(\tau^1,\tau^2)$ for all policies, I shall assume that $P_i(\tau^1,\tau^2) = -\infty$ for all τ for which there is no competitive equilibrium. If fiscal deficits are so large that there is no equilibrium, financial markets break down, and in that case I assume that governments suffer large political costs [7].

Given the social welfare functions defined by (8), we can see that fiscal deficit policies affect social objectives both directly and indirectly through equilibrium interest rates. Since the latter are determined in financial markets, the welfare effects of government deficits depend on the degree of international financial integration. This is the issue that we discuss in the sections below.

III. Equilibrium and Optimal Fiscal Deficits Without Financial Capital Mobility

In this section I derive optimal deficit policies and equilibrium interest rates and allocations in a Portfolio Autarky regime. In a PA world, capital markets are segmented across countries and interest rates in the two countries may be different. Even with free trade in consumption goods, a consequence of this segmentation is that fiscal deficits have no international effects: interest rates and real allocations in country i depend only on government i's fiscal deficit policy τ^i, and not on the other government's policy. Thus, in a PA regime government policies are <u>not</u>

interdependent, and there is no need for international policy coordination.

We shall see later that a PA regime may imply welfare losses. Since international borrowing is not possible in PA, trade must be balanced in all periods. As a result, aggregate consumption in each country must fluctuate: Portfolio Autarky implies that consumption smoothing is not possible.

III.a. <u>Competitive Equilibrium in Portfolio Autarky</u>

Equilibrium is defined relative to a policy pair $\tau = (\tau^1, \tau^2)$. Given (τ^1, τ^2) a <u>PA competitive equilibrium</u> is a collection of sequences of nonnegative consumption and labor effort $\{(n_{it}, c_{it})\}_{t=1}^{\infty}$, interest rates $\{R_{it}\}_{t=1}^{\infty}$, and debt quantities $\{b_{it}\}_{t=1}^{\infty}$ such that for all $t \geq 1$ and $i = 1, 2$:

[PA1] $\{b_{it}\}$ and τ^i satisfy (5), given $\{R_{it}\}$ and $b_{i0} = 0$.

[PA2] n_{it} and $c_{i,t+1}$ maximize (1) subject to (2), given $R_{it}, \tau_{i,t+1}$, and (6)

[PA3] $n_{it} = b_{it}$

[PA1] states that the government budget constraint is always satisfied. [PA2] implies that private agents act optimally. [PA3] is the market clearing condition in PA: it states that the demand for assets equals the supply for assets in each period, in each country. By Walras' Law, the world market for the consumption good also clears in each period.

The remainder of this subsection characterizes the set of policies that are <u>feasible in PA,</u> that is , the set of $\tau = (\tau^1, \tau^2)$ for which there is a (unique) PA competitive equilibrium. We can proceed recursively as in Chang (1988).

It is useful to define a "state" variable $x_{it} = R_{i,t-1} b_{i,t-1}$. x_{it} is the debt service of government i due at t. Because there is no debt at the beginning of time, $x_{i0} = 0$.

Suppose that government i chooses a transfer τ_{it} in period t. When is τ_{it} feasible at t? First, τ_{it} must assign nonnegative consumption to agent (i,t-1). In addition, the resulting amount of debt b_{it} must be no larger than N. Since $b_{it} = x_{it} + \tau_{it} = c_{i,t-1}$, both constraints are summarized by:

$$0 \le x_t + \tau_{it} \le N \tag{9}$$

If (9) is satisfied, then the interest rate at t and the next period debt service are determined by:

$$R_{it} = \frac{1}{K_{i,t+1}} (x_{it} + \tau_{it}) \tag{10a}$$

$$x_{i,t+1} = \frac{1}{K_{i,t+1}} (x_{it} + \tau_{it})^2 \tag{10b}$$

It follows that $\tau = (\tau^1, \tau^2)$ is feasible in PA if and only if (9) and (10b) are satisfied for all t, given $x_{i0} = 0$. Let Ω be the set of all joint policies that are feasible in PA, i.e., $\Omega = \{\tau = (\tau^1, \tau^2) \mid$ (9) and (10b) are satisfied for all t given $x_{10} = x_{20} = 0\}$

If $\tau \in \Omega$, then the equilibrium sequence of interest rates $\{R_{it}\}$ is given by (10a) and labor supply, production, consumption, and private welfare are given by equations (5) and (6). Notice that (9) and (10) imply that equilibrium interest rates and real allocations in country i depend only on its own deficit policy τ^i.

III.b. Optimal Fiscal Deficits in Portfolio Autarky

We are now ready to derive optimal fiscal deficits, equilibrium allocations, and welfare in a PA world. In order to accomplish this, we must solve the decision problem faced by each government. There is no loss of generality in assuming that governments do not coordinate their policies, because fiscal deficits have no international effects in PA.

The problem of government i is to choose a deficit policy τ^i in order to maximize (8) subject to (9), (10) and $x_{i0} = 0$. This is a simple recursive dynamic programming problem in which the <u>state of country i at t</u> is $(x_{it}, K_{it}) \in X \times \{H,L\}$. Given (x_{it}, K_{it}), government i can choose an <u>action</u> τ_{it} in the interval defined by (9). Next period state is then determined by (6) and (10b). By using (10a) in (8), it follows that the <u>one period reward</u> of government i at t is:

$$U(x_{it}, K_{it}, \tau_{it}) = (1-\beta)\left[\frac{K_{it}\tau_{it}}{\beta} + \frac{1}{2}(x_{it} + \tau_{it})^2\right] \tag{11}$$

Since (x,K,τ) must be an element of $X \times \{H,L\} \times [0,N]$, which is a compact set. Therefore returns are bounded and standard arguments apply (see Lucas and Stokey (1989,Ch.4)). Let $v(x_{it}, K_{it})$ be the maximized value of the objective function (8) for government i at t if the state is (x_{it}, K_{it}). Then v is the only solution of the functional equation:

$$v(x,K) = \max_{\tau} \; U(x,K,\tau) + \beta\, v(x',K') \tag{P1}$$

subject to $0 \le x+\tau \le N$, $x' = \dfrac{1}{K'}(x+\tau)^2$ and

$$\begin{aligned} K' &= L \quad \text{if } K = H \\ &= H \quad \text{if } K = L \end{aligned}$$

The solution of (P1) is straightforward and left to the reader. The result of interest is that government i's optimal deficit at t is a function of the "state" (x_{it},K_{it}) given by:

$$\tau_{it} = \tau_{PA}(x_{it},K_{it}) = \frac{K_{it}}{\beta} - x_{it} \tag{12}$$

and that the value function v(x,K) is given by:

$$v(x,K) = A_K - \frac{K(1-\beta)}{\beta}\, x \tag{13}$$

where $A_K \equiv \frac{1}{2(1+\beta)\beta^2} \ (K^2 + \beta\, K'^2)$.

From (13), it is immediate to obtain the payoffs for both governments, i.e., the <u>value of PA</u> for each government. The payoff for government 1, for instance, is just the value function evaluated at $(x_{11},K_{11}) = (0,H)$. Now, from (13), $v(0,H) = (H^2 + \beta L^2)[2\ \beta^2(1+\beta)]^{-1} \equiv v_1^{PA}$. Analogously, $v_2^{PA} \equiv v(0,L) = (L^2 + \beta H^2)[2\ \beta^2(1+\beta)]^{-1}$.

Let us examine some properties of PA optimal policies. First, we must notice that (given x_{it}) the deficit of government i at t, τ_{it}, is larger or smaller according to the size of K_{it}. The intuition of this result is, of course, that K_{it} is the marginal utility of the consumption of the old generation alive in country i at t. When $K_{it} = H$, government i has a large incentive to give a transfer to old agents and vice versa.

Second, equations (10a) and (12) imply that interest rates are given by:

$$R_{it} = \frac{K_{it}}{\beta\ K_{i,t+1}} \tag{14}$$

That is, the interest rate in country i fluctuates over time. In country 1, for instance, (14) says that the interest rate is high (equal to $H/\beta L$) in odd periods and low (equal to $L/\beta H$) in even periods. Correspondingly, consumption, production, savings, and debt service fluctuate in both countries. In particular, debt service is given by:

$$x_{it} = \frac{K_{i,t+1}}{\beta^2 K_{it}} \tag{15}$$

The fact that optimal deficit policies cannot eliminate fluctuations is due to the impossibility of international borrowing and lending under PA. In this model, country specific resources fluctuate but countries cannot smooth their aggregate consumption over time because trade must be balanced in each period.

The reader may have noticed that $v_1^{PA} > v_2^{PA}$ if $\beta < 1$. This obtains because $K_{11} = H > L = K_{21}$, and discounting of the future implies that at $t = 1$ country 1 is in a better position than country 2. However, the difference disappears as β goes to one, and in the limit both countries attain the same utility.

We summarize these results in:

<u>Proposition</u> <u>1</u>. Assume there is a PA regime and that each government chooses its fiscal deficit policy to maximize the payoff function (8). Then the optimal deficit policies are given by (12). The actual sequences τ^i are given by (12), (10b) and $x_{i1} = 0$. Under these policies, interest rates fluctuate as given by (14). The payoff of government i is given by $v_i^{PA} = v(0,K_{i1})$, where v is defined by (13). As $\beta \to 1$, v_1^{PA} and v_2^{PA} converge to the

same number. ∎

IV. The Gains From Financial Integration Under International Cooperation

In the next two sections we discuss a world of perfect capital mobility (CM), that is, a world in which residents of both countries can freely borrow from or lend to residents of other countries. We will compare equilibrium allocations and welfare under CM *vis a vis* PA in order to gain understanding of the welfare gains from financial integration.

In contrast with PA, international capital mobility implies that interest rates must be linked across countries. Indeed, in our deterministic model interest rates must be equal to each other, and thus one can properly define "the" world interest rate $R_t \equiv R_{1t} = R_{2t}$.

Under CM, the equilibrium sequence of world interest rates depend on both fiscal deficit policies τ^1 and τ^2. This contrasts with PA, in which $\{R_{it}\}$ depends only on τ^i. As a consequence, fiscal deficits have international effects: a fiscal deficit of government 1 affects, through its effect on the world interest rate, real allocations and welfare in country 2 and vice versa.

Whether or not government 1 takes into account this external effect when choosing its fiscal deficits determines which policy it will actually choose. In other words, the optimal choice of fiscal deficit policies depends on whether or not there is international policy cooperation.

In this section we examine competitive equilibrium in a CM regime in the assumption that governments agree on a symmetric cooperative scheme. This case will be called a cooperative CM regime. I show that world welfare is greater in a cooperative CM regime than under PA. The gains from CM depend on the structure of world fluctuations, and can be very "large". This provides a justification of financial integration on welfare grounds.

IV.a. Competitive Equilibrium and Feasible Policies in CM

In this subsection I define competitive equilibrium and the set of feasible policies under CM. Competitive equilibrium is defined relative to a given pair of policies $\tau = (\tau^1, \tau^2)$. Given (τ^1, τ^2), a world competitive equilibrium under CM is a sequence of world interest rates $\{R_t\}$, debt quantities $\{b_{1t}, b_{2t}\}$, and nonnegative labor effort and old age consumption for each agent $\{(n_{it}, c_{i,t+1})\}$, such that for all $t \geq 1$ and $i = 1,2$:

(CM1) Given $R_{it} = R_t$ and $\tau_{i,t+1}$, $(n_{it}, c_{i,t+1})$ maximizes (1) subject to (2)

(CM2) Given $b_{i0}=0$, and $\{R_t\}$, (b_{it}, τ_{it}) satisfies (6)

(CM3) $b_{1t} + b_{2t} = n_{1t} + n_{2t}$ for all $t \geq 1$

Condition (CM1) states that given interest rates and government transfers, each individual is maximizing utility. Condition (CM2) states that governments budget constraints are always satisfied. Finally, condition (CM3) is the market clearing condition under CM: it states that the world supply of assets equals the world demand for assets in each period.

The set of feasible policies under CM, that is, the set of joint policies for which there is a competitive equilibrium under CM, can be characterized recursively as in my (1988) paper. Let $x_t = R_{t-1}(b_{1,t-1} + b_{2,t-1})$ denote the total world debt service due at t. Suppose that x_t is given: Under which conditions is a pair of deficits (τ_{1t}, τ_{2t}) feasible at t? First, total debt supply must be no greater than the maximum possible world savings:

$$x_t + \tau_{1t} + \tau_{2t} \leq 2N \tag{16a}$$

The second condition is that τ_{it} must assign nonnegative consumption to (i,t-1). This condition can be expressed by:

$$\frac{K_{it}}{H + L} x_t + \tau_{it} \geq 0 \qquad (16b)$$

If (τ_{1t},τ_{2t}) satisfies (16), then there is a value of the world interest rate that clears the world asset market. This equilibrium interest rate is given by:

$$R_t = \frac{1}{H+L} (x_t + \tau_{1t} + \tau_{2t}) \qquad (17)$$

And the next period world debt service is given by:

$$x_{t+1} = \frac{1}{H+L} (x_t + \tau_{1t} + \tau_{2t})^2 \qquad (18)$$

A joint policy $\tau = (\tau^1,\tau^2)$ is feasible, i.e., is consistent with a CM competitive equilibrium if and only if (16) and (18) are satisfied for all t, given $x_1 = 0$. We shall denote by Γ the set of all feasible policies. Therefore, $\Gamma = \{ \tau = (\tau^1,\tau^2) \mid$ (16) and (18) are satisfied for all $t \geq 1$ when $x_1 = 0\}$.

Notice that for any feasible policy $(\tau^1,\tau^2) \in \Gamma$, the equilibrium sequence of interest rates is given by (17). Then production, consumption and private welfare in both countries is determined by (3) and (4). Then a feasible policy determines a whole dynamic equilibrium path for the world economy. A crucial aspect of competitive equilibrium is that it depends on <u>both</u> fiscal deficit policies τ^1 and τ^2.

IV.b. Optimal Fiscal Deficits and Welfare Under Cooperation

Now we ask the question: What fiscal deficits will governments choose if there is international policy coordination? An answer will be obtained in this section by assuming that both governments delegate their national power to a "world planner" that is instructed to maximize a "world welfare function". This case will be called a "cooperative CM" regime.

Which world welfare function the planner is suppose to maximize is a crucial question in the cooperative case. I will assume that the planner is instructed to choose a policy pair $\tau = (\tau^1,\tau^2)$ in order to maximize the sum of government payoffs $P_1 + P_2$, where P_i is given by (7). This welfare criterion treats both countries symmetrically. One may object to this symmetry on the grounds that countries are not the same at $t = 1$. In spite of this objection, I think that the symmetric case is important because the choice of the world planner's criterion might be based in political considerations that may have no relation to economic considerations. A second justification is that for low discount factors (β close to one) countries become almost symmetric. Indeed, we will pay particular attention to the outcomes when β goes to one.

Under the above assumption, the world planner's problem is to choose a feasible policy $\tau = (\tau^1,\tau^2) \in \Gamma$ to maximize $P_1(\tau^1,\tau^2) + P_2(\tau^1,\tau^2)$, where $P_i(.,.)$ is defined in (8). Using (17), this is a recursive discounted dynamic programming problem: the planner must choose τ to:

$$\text{Max} \sum_{t=1}^{\infty} \beta^{t-1} W(x_t, K_{1t}, K_{2t}, \tau_{1t}, \tau_{2t})$$

subject to (16) and (18), given $x_1 = 0$, where the one period reward function W is defined by:

$$W(x,K_1,K_2,\tau_1,\tau_2) = (1-\beta)\left[\frac{K_1\tau_1 + K_2\tau_2}{\beta} + \frac{H^2+L^2}{2\,(H^2+L^2)}(x+\tau_1+\tau_2)^2\right] \quad (19)$$

In this problem, the <u>state of the world at t</u> is the triple (x_t, K_{1t}, K_{2t}). Given the state at t, (16) defines the set of feasible actions (τ_{1t}, τ_{2t}). The transition of the system is defined by (18) and (6). Notice that the set of possible states and actions is compact [8] and therefore standard arguments apply.

Let $v(x,K_1,K_2)$ the value of the objective function for a planner when the initial state is (x,K_1,K_2). Then $v(x,K_1,K_2)$ is the only bounded function that solves the functional equation:

$$v(x,K_1,K_2) = \text{Max} \;\; W(x,K_1,K_2,\tau_1,\tau_2) + \beta\, v(x',\, K_1',\, K_2') \quad \text{(P2)}$$

where the choice variable is (τ_1,τ_2) subject to the feasibility constraints:

$$x + \tau_1 + \tau_2 \le 2N$$

$$\frac{K_i}{H+L}\, x + \tau_i \ge 0, \qquad i = 1,2$$

and the transition equations:

$$x' = \frac{1}{H+L}(x+\tau_1+\tau_2)^2$$

$$K_1' = K_2,\; K_2' = K_1$$

The solution of (P2) is straightforward. The reader can check directly that the value function is given by:

$$v(x,K_1,K_2) = \frac{H^2 \ (H+L)^2}{2 \ \beta^2 \ (H^2+L^2)} - \frac{H^2 + L^2}{H + L} \ \frac{1-\beta}{\beta} \ x \tag{20}$$

and that the planner's optimal deficit τ_{it} is a function of the state at t given by:

$$\tau_{it} = \tau_i(x_t, K_{1t}, K_{2t}) = - \frac{L}{H + L} x_t \qquad \text{if } K_{it} = L \tag{21a}$$

$$= \frac{H \ (H+L)^2}{\beta \ (H^2+L^2)} - \frac{H}{H + L} x_t \qquad \text{if } K_{it} = H \tag{21b}$$

It turns out that the cooperative policy (21) completely stabilizes the world economy in the sense that the resulting world interest rate and the amount of world debt are constant over time. To see this, notice that (17), (18) and (21) imply that for all $t \geq 1$:

$$R_t = \frac{H \ (H+L)}{\beta \ (H^2 + L^2)} \tag{22a}$$

$$x_{t+1} = \frac{H^2 \ (H+L)^3}{\beta^2 (H^2+L^2)^2} \tag{22b}$$

The planner can choose to stabilize the world economy because, although country specific savings fluctuate, the world fundamentals do not. In contrast with PA, consumption smoothing across countries is possible. It can be checked that the cooperative policies (21) result in current account surpluses and deficits for each country.

What welfare level results from CM? From an international perspective, the relevant criterion is the maximized value of the planner's objective, which we will call the <u>world value of cooperation</u> and denote by v_c. The value of cooperation is immediately obtained from (20): Since the state at t=1 is $(x_1, K_{11}, K_{21}) = (0,H,L)$, v_c can be defined as $v_c = v(0,H,L) = \frac{H^2 (H+L)^2}{2 \beta^2 (H^2+L^2)}$.

We can also obtain the payoff that each government receives under the cooperative policy (21). This may be important, because a country will not agree on a cooperative scheme if its payoff is less than the value of PA. The payoff of government i under cooperation will be called the <u>value of cooperation for government i</u> and denoted by v_i^c. v_i^c can be obtained by substituting (21) and (22) in (10). After simplification, one obtains that the value of cooperation for government 1, v_1^c, is equal to λv^c, where v^c is the world value of cooperation and the share λ is defined by:

$$\lambda = \frac{L^2 + (2-\beta) H^2}{(1+\beta) (H^2+L^2)} \tag{23}$$

Analogously, the value of cooperation for government 2 is $(1-\lambda)v^c$. Notice that as $\beta \to 1$, $\lambda \to 1/2$. That is, as the rate of time preference decreases both governments benefit equally from the cooperative scheme.

We summarize the results of this subsection in

<u>Proposition 2</u>. Assume that a world planner chooses a joint policy τ to maximize a world welfare function equal to P_1+P_2. Then the optimal cooperative deficit policy is given by (21). The actual sequence of deficits (τ^1, τ^2) is determined by (21), (22b), and $x_1 = 0$. Under the optimal cooperative policy, the world interest rate and the quantity of world debt are constant and given by (22). The value of the world welfare function is $v^c =$

$\frac{H^2 (H+L)^2}{2 \beta^2 (H^2+L^2)}$. The value of cooperation for governments 1 and 2 are, respectively, λv^c and $(1-\lambda)v^c$, where λ is defined in (23). ▮

IV.c. <u>The Welfare Gains From Financial Integration</u>

To assess the welfare gains from capital mobility, we can adopt an "international" or a "national" perspective. From an international viewpoint we can compare the value of the world planner's objective function P_1+P_2 under CM and under PA. From a national perspective, the question is whether the country specific payoff of government i, P_i, is greater under a CM regime than in PA. We consider them in turn.

The value of the planner's objective $P_1 + P_2$ in CM is simply the world value of cooperation v^c. Under PA, the value of $P_1 + P_2$ is equal to the sum of the payoffs that both governments obtain under PA, i.e., equal to $v_1^{PA}+ v_2^{PA}$. We will denote this sum by v^{PA}, the <u>world value of PA</u>. From subsection III.c. it follows that $v^{PA}= \frac{H^2 + L^2}{2 \beta^2}$.

Now, a simple way to compare CM and PA is to examine the ratio $\theta = \frac{v^c}{v^{PA}}$. From the definition of v^c and v^{PA}:

$$\theta = \frac{H^2 (H+L)^2}{(H^2+L^2)^2} \tag{24}$$

Recalling that $H \geq L > 0$, it follows that $\theta \geq 1$, with strict inequality if $H > L$. The lesson is that, from a world perspective, capital mobility is always superior to portfolio autarky if governments cooperate. CM is <u>strictly</u> superior to PA unless countries are identical.

The second lesson of (24) is that for some values of H and L the ratio θ can be considerably larger than one. For instance, if H = 2 and L = 1 the value of θ is 1.44. In other words, capital mobility results in a welfare increase of 44% over portfolio autarky! Of course, one can choose values of H and L such that θ is close to one. And moreover, this comparison depends on the assumed cardinal properties of utility functions. But the result is nonetheless relevant: some authors (such as Cole and Obstfeld (1988)) have claimed that the welfare gains from capital mobility in dynamic optimizing models are typically small. This model is a counterexample of that claim.

Now we consider PA and CM from a national perspective. In particular, we ask the question: Under which conditions will country i agree to enter a symmetric cooperative scheme under CM instead of portfolio autarky? The answer, naturally, depends on the comparison between the value of cooperation for country i and the value of PA for country i. Now, from the definitions of v_i^c and v_i^{PA} it follows that:

$$\frac{v_i^c}{v_i^{PA}} = \theta\ \omega_i \tag{25a}$$

$$\text{where: } \omega_1 = \frac{L^2 + (2-\beta)H^2}{H^2 + \beta\ L^2}\ , \qquad \omega_2 = \frac{\beta L^2 + (2\beta-1)H^2}{L^2 + \beta\ H^2} \tag{25b}$$

and θ is defined by (24).

Equations (24) and (25) provide a complete description of the incentives for each country to agree on financial integration. For all admissible parameters, country 1 always prefers CM: θ and ω_1 are always greater than or equal to one. This is intuitive because CM must make at least one country better off relative to PA, and country 1 has an advantageous position at t = 1 because it has a high value of K.

Country 2 may or may not prefer a cooperative CM regime to PA: θ is never less than one, but ω_2 may be greater or less than one, and therefore v_2^c may be greater than or less than v_2^{PA}. Notice however that if $\theta > 1$, for values of β close to one, ω_2 is also close to one and v_2^c must be strictly greater than v_2^{PA}. The intuition is that as government 2's criterion approaches an average criterion, its initial disadvantage disappears.

We summarize the results of this subsection in:

Proposition 3. From the viewpoint of a world planner that maximizes P_1+P_2, CM results in higher world welfare than PA. The aggregate gains from CM can be large or small depending on the structure of world fluctuations.

Country 1 always benefits from financial integration, assuming governments coordinate their policies. Country 2 may or may not benefit. Country 2 always benefits, however, if β is sufficiently close to one. ∎

V. Financial Integration Without International Policy Coordination

The previous section examined the properties of a CM regime under the assumption that governments set up a symmetric coordinating scheme. In this section we relax the assumption of coordination, and ask what would happen if there is capital mobility but governments act noncooperatively. In short, we shall study a noncooperative CM regime.

In the absence of coordination, I have shown elsewhere (Chang (1988)) that governments have an incentive to run fiscal deficits that are too large. In a CM regime the fiscal deficit of government 1 increases world interest rates and thus affects country 2's real allocations and welfare. Without international policy coordination, government 1 will understate the cost of its deficits. Of course, the same is true of government 2. The result may be a pair of deficit policies that are larger than under cooperation.

In this section I analyze the noncooperative CM regime as a dynamic game. I show that this game possesses a Nash equilibrium in which fiscal deficits are larger, the world interest rate larger, and world welfare lower than under cooperation. I also show that, provided β is close to one, both countries are worse off in the noncooperative equilibrium.

Then I ask the question, are countries better off in a noncooperative CM regime than in PA? In this section I show that the answer, perhaps surprisingly, is negative. More precisely, I show that world welfare in PA is larger than world welfare under a noncooperative CM regime. I also show that if β is close to one both countries are worse off in a noncooperative CM regime than in PA.

The policy message of this section is, therefore, that financial integration can be counterproductive if governments do not coordinate their fiscal deficit policies.

V.a. Noncooperative Markov Nash Equilibrium

The outcomes of a noncooperative CM regime can be regarded as the noncooperative equilibria of a dynamic game. In this game, governments 1 and 2 are the players. The fiscal policy chosen by each government is its strategy. Given a joint strategy, the payoff for government i is the value of the social welfare function defined by (7).

I will focus on the Nash equilibria of the game. A Nash equilibrium (NE) is a pair of strategies, one for each player, such that each player's strategy maximizes its payoff given the other government's strategy.

Strategies can be, in principle, functions of the whole history of the game. Given the recursive structure of the model, I shall restrict attention to Markov Nash Equilibria (MNE), that is, Nash equilibria in Markov strategies. A Markov strategy for player i is a real valued function $\tau_{it} = \tau_i(x_t, K_{1t}, K_{2t})$. Thus, a Markov strategy for i is such that the deficit actually chosen by government i at t is a function of the "state" at t.

Focusing in Markov strategies is natural because the best response to a Markov strategy is itself Markov. To see this, suppose that government 2 is using a Markov strategy $\tau_2(x, K_1, K_2)$. What is the optimal strategy of government 1? From (7), (16), (17) and (18) it follows that the problem of government 1 is to choose $\tau^1 = \{\tau_{1t}\}$ to maximize:

$$\sum_{t=1}^{\infty} \beta^{t-1} W_1(x_t, K_{1t}, K_{2t}, \tau_{1t})$$

subject to (16b), $x_1 = 0$, and:

$$x_t + \tau_{1t} + \tau_2(x_t, K_{1t}, K_{2t}) \leq 2N \tag{26a}$$

$$x_{t+1} = \frac{1}{H + L} (x_t + \tau_{1t} + \tau_2(x_t, K_{1t}, K_{2t}))^2 \tag{26b}$$

where the one period reward function is given by:

$$W_1(x, K_1, K_2, \tau_1) = (1-\beta) \left[\frac{K_1 \tau_1}{\beta} + \frac{K_2^2}{(H+L)^2} (x + \tau_1 + \tau_2(x, K_1, K_2))^2 \right] \tag{27}$$

This is just a discounted dynamic programming problem, and government 1's optimal strategy is a Markov policy $\tau_1(x, K_1, K_2)$. Thus, government 1's best response to a Markov strategy is also Markov.

Finding MNE is equivalent to finding two Markov policies $\tau_i(x, K_1, K_2)$, i =1,2, such that $\tau_1(.)$ is a best response to $\tau_2(.)$ and vice versa. The calculation of MNE is cumbersome. I relegate technical details to the Appendix and collect the results in:

Proposition 4. Assume a noncooperative CM regime, and that the parameters of the model satisfy the following assumption:

$$(H+L)^2(H^2+L^2)^2 \geq 4\beta\ HL\ N^2\ (H^3-L^3) \text{ and } 2(H+L)(H^2+L^2) \leq \beta\ HL\ N. \quad \text{(AS)}$$

Then the following pair of strategies is a MNE:

$$\tau_i(x_t, K_{1t}, K_{2t}) = \gamma + \mu_i(K_{1t}, K_{2t})x_t, \quad i = 1,2 \quad \text{(28a)}$$

where :

$$\gamma = \frac{(H+L)\ (H^2+L^2)}{2\beta HL} \quad \text{(28b)}$$

$$\mu_1(K_1, K_2) = -\frac{K_1^3 - K_2^3 + 2K_2^2\ (H+L)}{2(H+L)\ (H^2+L^2)} \quad \text{(28c)}$$

$$\mu_2(K_1, K_2) = -\frac{K_2^3 - K_1^3 + 2K_1^2\ (H+L)}{2(H+L)\ (H^2+L^2)} \quad \text{(28d)}$$

The value function for government $i = 1,2$ is given by:

$$v_i(x,\ K_1, K_2) = A_i(K_1, K_2) + \frac{(1-\beta)\ K_i}{\beta}\ \mu_i(K_1, K_2)\ x \quad \text{(29a)}$$

where $A_1(H,L) = A_2(L,H) = \alpha$, $A_1(L,H) = A_2(H,L) = -\alpha$, and α is given by:

$$(1+\beta)\alpha = \left[\frac{H}{\beta} + L \right]\gamma +$$

$$\left(\frac{H^2 + L^2}{\beta HL} \right)^2 \left[\frac{L^2 + \beta H^2}{2} + (H+L) \ (L\mu_1(L,H) + \beta \ H\mu_1(H,L)) \right] \tag{29b}$$

Finally, $\alpha \to 0$ as $\beta \to 0$.

∎

Assumption (AS) in Proposition 4 is a sufficient but by no means a necessary condition for the MNE. The Appendix shows that the role of (AS) is to ensure that the solutions of the maximization problems of both governments are always interior and characterized by first order conditions. Thus, I make the assumption (AS) for simplicity: without (AS), MNE policies may require corner solutions for some values of x, and MNE would become much more complicated. Notice also that (AS) can always be satisfied if (H^3-L^3) is sufficiently small [9], and therefore Proposition 4 is not vacuous.

In the rest of this subsection I compare the outcome of this MNE with the outcome of the cooperative CM regime.

To begin, notice that the MNE strategies result on the complete stabilization of the world economy, in the sense that the world interest rate and the amount of world debt service is constant for all periods. This follows from using (28) in (17) and (18) to get:

$$R_t = \frac{H^2 + L^2}{\beta HL} \tag{30a}$$

$$x_{t+1} = \left(\frac{H^2 + L^2}{\beta HL} \right)^2 (H+L) \tag{30b}$$

The fact that MNE policies stabilize the world economy could suggest that they are similar to cooperative policies. However, from (22a) and (30a) it follows that world interest rates are larger in a MNE than in a cooperative regime. This is because the MNE are larger on the average than the cooperative deficits [10].

The intuition, of course, is that the fiscal deficits of government 1 affect R_t and therefore welfare in country 2. In the absence of cooperation, government 1 ignores this international effect of its deficit. As government 2 does the same, the outcome is that fiscal deficits tend to be too large.

The payoff that government i receives in the MNE can be called the <u>value of noncooperation for government i</u> and denoted by v_i^N. The values of noncooperation can be calculated directly from (29): $v_1^N = v_1(0,H,L) = A_1(H,L) = \alpha$. Analogously, $v_2^N = -\alpha$

The "world" value of noncooperation can be defined as $v^N = v_1^N + v_2^N$, and, by the previous argument, $v^N = 0$. Thus, from an international perspective the cooperative CM regime is superior to a noncooperative CM regime.

From a national perspective, government i would prefer a cooperative CM regime to a noncooperative CM regime if $v_i^N \leq v_i^c$. Since the expression for v_i^N is very complex, little can be said in general. However, it is easy to see from (29) that $v_i^N \to 0$ as $\beta \to 1$. Since $v_i^c \to v^c/2 > 0$ as $\beta \to 1$, it follows that for β sufficiently large <u>both</u> governments are better off in a cooperative CM regime.

V.b. <u>The Welfare Losses from Financial Integration in the Absence of International Policy Coordination</u>

Are countries better off in a PA regime or in a <u>noncooperative</u> CM regime? The answer can again be considered from an international and a national perspective.

From an international perspective, the question is whether v^N is greater or less than v^{PA}, i.e., whether the world value of noncooperation is greater than the world value of autarky. But $v^N = 0$ while $v^{PA} > 0$. Thus, <u>a noncooperative CM regime results in a world welfare loss relative to PA.</u>

This result is strong in the sense that it does not depend on the particular values of H and L. This is surprising, because one could have expected a tradeoff between the gains from capital mobility and the losses from noncooperative behavior. From an international point of view, such a tradeoff does not exist: Portfolio autarky is superior to capital mobility in the absence of international policy coordination.

From a national perspective, we can ask: would government i prefer PA to a noncooperative CM regime? The answer lies in the comparison of v_i^{PA} and v_i^N. Because v_i^N is a function of α and α is a very complex function of β,H and L, little can be said in general. However, we know that at least one of the v_i^N must be negative. Since both v_i^{PA} are positive, it follows that at least one of the countries is better off in PA than in a noncooperative CM. We also know that as $\beta \to 1$, then $v_i^N \to 0$ while $v_i^{PA} \to v^{PA}/2 > 0$. Thus, for sufficiently large values of β <u>both</u> countries are better off in PA.

These results are summarized in

<u>Proposition 5.</u> From the viewpoint of a world planner that maximizes P_1+P_2, PA results in higher world welfare than a noncooperative CM regime. At least one of the countries is better off in PA than in a noncooperative CM regime. If β is close to one, both countries are better off in PA. ∎

VI. <u>Final Remarks</u>

This paper has studied a model with and without international capital mobility and with and without international policy coordination. The main results are (i) that international capital mobility may result in substantially higher welfare levels than portfolio autarky provided governments cooperate in the management of fiscal deficit policies, and (ii) if governments do not cooperate, then capital mobility may result in substantially lower welfare levels than capital mobility.

The main qualification to these results is that the symmetric MNE discussed in Section V may not be the unique NE of the noncooperative CM regime. Indeed, there may be a NE in which cooperative policies are supported by noncooperative strategies based on threats and reputation (as in Benhabib and Radner (1988) and Chang (1988)). Short of a theory of how a particular NE will be selected, result (ii) can be restated as follows: if governments do not cooperate implicitly or explicitly, then financial integration may make all countries worse off.

The main intuition of the paper is that financial integration increases the international effects of domestic financial policies (such as deficit policies), which tends to decrease welfare if governments act noncooperatively. The increased losses from noncooperative behavior may outweigh the benefits from financial integration. Then one can be sure that financial integration improves welfare if and only if there is international cooperation. Such an intuition is very robust and I expect it to apply to a wide class of models.

Throughout the paper, we have assumed that the international regime is given. One could ask: why would governments agree to dismantle restrictions on capital flows if they are not going to cooperate? there are many possible answers.

The first is simply that government may believe that the gains from capital mobility are so large that they must exceed its costs. However, we have shown that this belief is unfounded, and that there is no relation between the potential gains from financial integration and the actual, realized gains. In the model above, the potential gains from capital mobility can be very large, and nevertheless countries are better off in PA if governments do not cooperate.

Alternatively, one could argue that the decisions of whether or not to impose restrictions on international capital markets are also policy variables and that "rational" governments would not choose to abolish capital markets restrictions if they did not expect to cooperate later. Indeed one can view the problem in this way and indeed the choice of a regime can be considered as as an outcome of a larger game. For instance, Hamada (1979, p.321) wrote:

> Generally speaking, international monetary conflicts or confrontations can be regarded as a two stage game: one is to agree on the rules of the game, and another is to play the policy based on one agreed rule of the game. Of course, the two stages are closely interrelated. The malfunctioning of the policy interplay based on a particular rule of the game may become incentives to change the rule itself.

Thus one can argue that governments choose capital mobility in the expectation that they will coordinate their macroeconomic policy. This idea is not at odds with the real world. For example, European governments have expressed some expectation of future cooperation as a results of financial integration (see Key (1989)). However, in previous work (Chang (1987)) I have shown that in such a two stage game governments may still choose a CM regime even if they do not cooperate in the second stage. To examine the incentives for governments to open international capital markets seems to be an open question.

Appendix

The purpose of this Appendix is to prove Proposition 4 in the text. Assume that government 2 is choosing its deficits according to a Markov strategy of the following form:

$$\tau_2(x,K_1,K_2) = \gamma_2 + \mu_2(K_1,K_2)\ x \tag{A1}$$

where γ_2 is a constant and $\mu_2(.,.)$ a number that depends only on (K_1,K_2) but not on x. I will first show that the best response of government 1 has the form $\tau_1(x,K_1,K_2) = \gamma_1 + \mu_1(K_1,K_2)\ x$.

As discussed in the text, the problem of government 1 is a recursive discounted dynamic programming problem and standard techniques apply. If we denote by $v_1(x,K_1,K_2)$ the solution of government 1's problem given that the initial "state" is (x,K_1,K_2), then $v_1(.)$ is the solution of the functional equation:

$$v_1(x,K_1,K_2) = \max_{\tau}\ W_1(x,K_1,K_2,\tau) + \beta\ v_1(x',\ K_2,K_1) \tag{A2}$$

subject to:

$$\frac{K_1}{H+L}\ x + \tau \geq 0 \tag{A3}$$

$$x + \tau + \tau_2(x,K_1,K_2) \leq 2N \tag{A4}$$

$$x' = \frac{1}{H+L}\ (x + \tau + \tau_2(x,K_1,K_2))^2 \tag{A5}$$

The first order condition for the maximization in (A2) is given by:

$$(1-\beta)\left[\frac{K_1}{\beta} + \frac{K_2^2}{(H+L)^2}\ (x+\tau+\tau_2)\right] + \frac{2\beta\ (x+\tau+\tau_2)}{H+L}\left[\frac{\partial v_1}{\partial x}\ (x',K_1,K_2)\right] = 0 \tag{A6}$$

Using the Benveniste-Scheinkman lemma , the partial derivative of v_1

w.r.t. x is, from (A2):

$$\frac{\partial v_1}{\partial x}(x,K_1,K_2) = (1+\mu_2(K_1,K_2))\left\{(1-\beta)\frac{K_2^2}{(H+L)^2}(x+\tau+\tau_2) + \frac{2\beta\,(x+\tau+\tau_2)}{H+L}\left[\frac{\partial v_1}{\partial x}(x',K_1,K_2)\right]\right\} \tag{A7}$$

Using (A7) in (A6) and simplifying, it follows that

$\frac{\partial v_1}{\partial x}(x,K_1,K_2) = -(1-\beta)\frac{K_1}{\beta}(1+\mu_2(K_1,K_2))$. Inserting this expression in (A3) and simplifying we obtain the optimal choice of τ in (A2), i.e., government 1's best response has the form $\tau_1(x,K_1,K_2) = \gamma_1 + \mu_1(K_1,K_2)\,x$, where:

$$\gamma_1 = \frac{K_1}{\beta}\left[\frac{2\,K_2\,(1+\mu_2(K_1,K_2))}{H+L} + \frac{K_2^2}{(H+L)^2}\right]^{-1} - \gamma_2 \tag{A8}$$

and: $$\mu_1(K_1,K_2) = -(1+\mu_2(K_1,K_2)) \tag{A9}$$

Now, we need to find coefficients γ_i and functions $\mu_i(K_1,K_2)$, i= 1,2 that solve (A8), (A9), and the corresponding equations for government 2. We will search for a solution that is symmetric in the sense that $\mu_1(K_1,K_2) = \mu_2(K_2,K_1)$ and $\gamma_1 = \gamma_2 = \gamma$. In this solution, the policy of government 2 in odd periods is the same as that of government 1 in even periods and vice versa.

We proceed as follows: (A8) implies that if γ is going to be independent of (K_1,K_2) it must be the case that:

$$\frac{K_1}{\beta}\left[\frac{2\,K_2\,(1+\mu_2(K_1,K_2))}{H+L} + \frac{K_2^2}{(H+L)^2}\right]^{-1} =$$

$$\frac{K_2}{\beta}\left[\frac{2\,K_1\,(1+\mu_2(K_2,K_1))}{H+L}+\frac{K_1^2}{(H+L)^2}\right]^{-1} \tag{A10}$$

Using (A9) in (A10) and simplifying we obtain the solution for $\mu_1(K_1,K_2)$ as given by equation (28c) of the text. Since we assumed symmetry, $\mu_2(K_1,K_2) = \mu_1(K_2,K_1)$, which implies (28d). Inserting (28c) in (A8) and assuming $\gamma_1 = \gamma_2 = \gamma$ gives the solution for γ in (28b).

From the expression for $\partial v_1/\partial x$ it follows that the value function v_1 takes the form given in (29a). Replacing (29a) and (28) in (A2) one obtains the following:

$$A_1(K_1,K_2) = (1-\beta)\left[\frac{K_1\gamma}{\beta}+\frac{K_2^2\,(H^2+L^2)^2}{2\,(\beta HL)^2}\right]$$
$$+\,\beta\left[A_1(K_2,K_1)+\frac{(1-\beta)\,K_2\,(H+L)\,(H^2+L^2)^2}{\beta^3\,(HL)^2}\,\mu_1(K_2,K_1)\right] \tag{A11}$$

which defines a system of two equations in the variables $A_1(H,L)$ and $A_1(L,H)$. defining $\alpha = A_1(H,L)$ and solving for α one obtains (29b). By using (A11) it is straightforward but very tedious to show that $A_1(H,L) + A_1(L,H) = 0$, and therefore $A_1(L,H) = -\alpha$. That $\alpha \to 0$ as $\beta \to 1$ is direct from (29b) and a proof is omitted.

To finish the proof, one must show that the MNE policies defined by (28) are always feasible. This requires showing that for all feasible x_t:

$$\frac{K_{it}}{H+L}\,x_t + \tau_i(x_t,K_{1t},K_{2t}) \geq 0 \tag{A12}$$

$$x_t + \tau_1(x_t,K_{1t},K_{2t}) + \tau_2(x_t,K_{1t},K_{2t}) \leq 2N \tag{A13}$$

By using (28) and the fact that $x_t \in [0,\, 4N^2/(H+L)]$, it follows that the condition $(H+L)^2(H^2+L^2)^2 \geq 4\ \beta\ HL\ N^2\ (H^3 - L^3)$ is sufficient (although not necessary) for (A12) to be satisfied. On the other hand, (28) implies that (A13) is satisfied for all x_t if $2(H+L)(H^2+L^2) \leq \beta HLN$. These are the assumptions in (AS). The proof is complete. ∎

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Footnotes

[1]For an overview of the recent process of financial integration, see Bryant (1987). A review of the European process is found in Key (1989)

[2]This model extends my 1988 paper to the case in which countries may be different at each point in time.

[3]The restriction to one consumption good is for simplicity only and it does not alter the results in any way.

[4]This is for simplicity only. It will become clear that initial conditions do not matter if governments do not discount the future too heavily. In any event, it is easy to alter the model to include initial government obligations.

[5] The term "Portfolio Autarky" belongs to Kareken and Wallace (1981)

[6]Thus the existence or absence of capital controls is taken as given. Alternatively, one could ask how capital controls are chosen by governments. For an attempt in this direction, see Chang (1987). See also Section VI.

[7]This assumption is not crucial for the results. See Chang (1988, Appendix) for the discussion of an alternative rule.

[8]This follows from (16) and the fact that $(x, K_1, K_2) \in X_w \times \{H,L\} \times \{H,L\}$, where $X_w = [0, 4N^2/(H+L)$

[9]More precisely, if $\beta HL \geq 16\ (H^3 - L^3)$ then there is always a value of N that satisfies (AS)

[10]Notice also that the absence of interest rate fluctuations is no evidence of cooperation.